

Fundamentals of Chemistry

Matter: Everything that has mass and volume

Mass: The amount of matter an object contains

Volume: The space (place) occupied by an object in vacuum

States of Matter : Solid (s) , Liquid (L) , Gaseous (g)

Matter → **Molecules** → **Atoms**

Molecule

The smallest part of matter that exists independently and retains the properties of matter

The molecule is divided into:

Element Molecule

Produced from the combination of similar atoms Such as: N_2 , Cl_2 , O_2

Compound Molecule

Produced from the combination of different atoms Such as: H_2O , $NaCl$, $MgSO_4$

Pay attention

there are elements that consist of one atom such as solid elements and inert gases, while there are 7 elements that consist of two identical atoms as shown in the following table:

Element	Symbol
Fluorine	F_2
Chlorine	Cl_2
Bromine	Br_2
Iodine	I_2
Hydrogen	H_2
Oxygen	O_2
Nitrogen	N_2

Atom

The building block of matter, usually does not exist independently, and participates

in chemical reactions.

The atom consists of:

Negatively charged electrons (-)

Revolve around the nucleus at ultra-high speeds in specific orbits known as energy levels.

Their mass is extremely negligible, so it can be omitted when compared to the mass of both protons and neutrons.

Every element has a chemical symbol consisting of one or two letters.

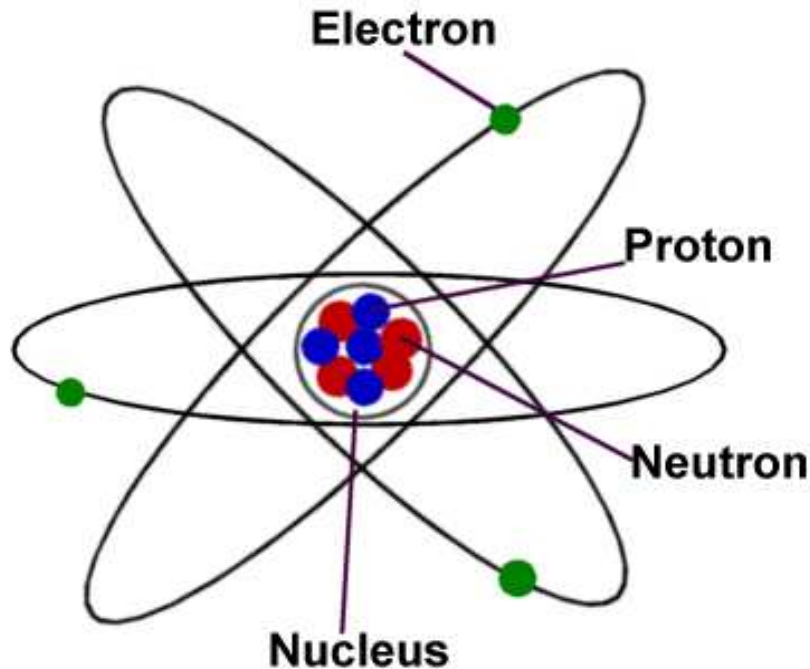
If it is one letter, it is written Capital, and if it is two letters, the first is written Capital and the second Small.

Positively charged nucleus (+)

The nucleus contains two types of particles:

Positively charged protons (+)

Neutrally charged neutrons ($\pm$)



Symbols of some chemical elements :

Element	Symbol	Element	Symbol
Hydrogen	H	Fluorine	F
Helium	He	Iron	Fe
Mercury	Hg	Phosphorus	P
Carbon	C	Lead	Pb
Chlorine	Cl	Argon	Ar
Calcium	Ca	Aluminum	Al
Copper	Cu	Gold	Au
Chromium	Cr	Silver	Ag
Oxygen	O	Zinc	Zn
Nitrogen	N	Magnesium	Mg
Neon	Ne	Iodine	I
Sodium	Na	Lithium	Li
Boron	B	Sulfur	S
Beryllium	Be	Silicon	Si
Bromine	Br	Nickel	Ni

When writing the symbol of an element, there is a number at the top left of the element called the **Mass Number**, and a number at the bottom left of the element called the **Atomic Number**.



Mass Number

The total number of protons and neutrons inside the nucleus of an element's atom.

Atomic Number

The number of positive protons only inside the nucleus of an element's atom.

To calculate the mass number and atomic number from these relations:

Mass Number = Number of Protons + Number of Neutrons

Atomic Number = Number of Protons = Number of Electrons

Number of Neutrons = Mass Number - Atomic Number

Energy Levels

Imaginary regions in which electrons revolve around the nucleus, each according to its energy.

The number of energy levels in the heaviest known atoms is 7 main energy levels.

The main energy levels are (K , L , M , N , O , P , Q).

- ★ The rule ($2n^2$) applies to the first four levels to calculate the number of electrons each main energy level is saturated with, where (n) refers to the level number.

Classification of Elements

Metals , Non-metals , Metalloids , Inert Gases

First: Metals

Elements whose last level contains less than 4 electrons.

Unstable elements that enter chemical reactions to become stable, tending to lose their valence electrons and turn into positive ions (cations).

Second: Non-metals

Elements whose last level contains more than 4 electrons.

Unstable elements that enter chemical reactions to become stable, tending to gain electrons and turn into negative ions (anions).

Third: Metalloids

Elements that have the appearance of metals and most of the properties of non-metals, as they cannot be identified by their electronic distribution but are recognized by their properties.



Element	Boron	Silicon	Germanium	Arsenic	Antimony	Tellurium
Symbol	B	Si	Ge	As	Sb	Te

Fourth: Inert Gases (Group Zero)

Elements that do not participate in chemical reactions under normal chemical conditions and participate under special conditions.

Inert gases consist of 6 elements:

Element	Helium	Neon	Argon	Krypton	Xenon	Radon
Symbol	He	Ne	Ar	Kr	Xe	Rn

Valency

The number of electrons lost or gained during a chemical reaction.

Valency is a characteristic property of matter (atoms of elements).

Meaning that the atom has its own valency, while the molecule has no valency (meaning the sum of the molecule's charges equals zero).

Atomic Group (Radical)

A group of different atoms bonded together that behave as a single atom during a chemical reaction and have a specific valency.

Atomic Group	Chemical Formula	Valency
Hydroxide	OH^-	Monovalent
Nitrate	NO_3^-	Monovalent
Nitrite	NO_2^-	Monovalent
Bicarbonate	HCO_3^-	Monovalent
Chlorite	ClO_2^-	Monovalent
Ammonium	NH_4^+	Monovalent
Carbonate	CO_3^{2-}	Divalent
Sulfate	SO_4^{2-}	Divalent
Sulfite	SO_3^{2-}	Divalent
Phosphate	PO_4^{3-}	Trivalent

How to write chemical formulas:

- (1) We write under the name of each element or atomic group its symbol or chemical formula.
- (2) We write below each element or atomic group its specific valency.
- (3) We exchange the valency of each by scissors method.

Write the chemical formulas for the following compounds:

Sodium Na Hydroxide OH 1 1 NaOH	Calcium Ca Sulphate SO₄ 2 2 CaSO₄
Magnesium Mg Nitrate NO₃ 2 1 Mg (NO₃)₂	Aluminum Al Carbonate CO₃ 3 2 Al₂ (CO₃)₃

Classification of Compounds

- (1) Acids (2) Alkalis (3) Oxides (4) Salts

First: Acids

Substances that produce positive hydrogen ions (H⁺) when dissociated in water.
Acids are classified into:

- (1) Oxyacids (2) Non-oxyacids

Naming oxyacids according to this rule:

Acid + name of the atomic group ending with (-ate) replacing (-ate) with (-ic)
Acid + name of the atomic group ending with (-ite) replacing (-ite) with (-ous)

★ Examples :

Sulfuric acid : **H₂SO₄**

Nitric acid : **HNO₃**

Nitrous acid : **HNO₂**

Sulfurous acid : **H₂SO₃**

Naming non-oxyacids according to this rule :

Acid + **hydro** + **name of non-metal** + **ic**

Examples :

HCl - Hydrochloric **acid**

HBr - Hydrobromic **acid**

Second: Alkalis

Compounds that give negative hydroxide ions (OH^-) when dissociated in water.

Naming alkalis

Hydroxide + **metal name**

Examples :

NaOH - Sodium **hydroxide**

KOH - Potassium **hydroxide**

Third: Oxides

Compounds produced from the combination of elements with oxygen.

Types of oxides:

(1) Basic oxides (2) Acidic oxides (3) Neutral oxides (4) Amphoteric oxides

Basic oxides

Oxides of metallic elements, some dissolve in water forming alkalis and react with acids forming salt and water.

Examples :

Magnesium oxide (**MgO**)

Calcium oxide (**CaO**)

Test your intelligence:

What is the difference between Alkali and Basic?

.....

Acidic oxides

Oxides of non-metallic elements that dissolve in water forming oxyacids, reacting with alkalis forming salt and water.

Examples : Carbon dioxide (CO_2), Sulfur trioxide (SO_3) $\text{H}_2\text{O} + \text{SO}_3 \rightarrow \text{H}_2\text{SO}_4$

Chemical Reaction

What is a chemical reaction?

It is the breaking of existing bonds in the reactant molecules and forming new bonds in the product molecules.

We express any chemical reaction with a chemical equation.

Chemical Equation

A set of chemical symbols or formulas showing both substances entering the reaction or resulting from it.

Types of chemical equations:

1. Word equations
2. Symbolic equations (Preferred because word equations do not show physical state or number of atoms/molecules).

Steps to write an equation :

1. Write reactants on the left and products on the right.
2. Write the physical state of reactants and products:
3. Write the equation balanced.

Physical State	Solid	Liquid	Gaseous	Vapor	Aqueous Solution
Symbol	s	L	g	v	aq

Balancing equation :

Done by placing coefficients (numbers) to the left of the substance so that the number of reactant atoms equals the product atoms.
Balancing is done on coefficients, not on subscripts

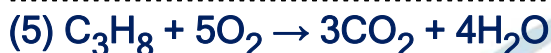
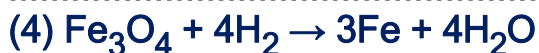
Reaction conditions :

Written on the reaction arrow (Heat Δ , Pressure P, Catalyst cat , Dilute acid dil , Concentrated acid conc).

Catalyst :

A substance that increases reaction speed without being consumed or changed

Balance the following equations:



Write balanced symbolic equations :

(1) Combustion of carbon in oxygen forming carbon dioxide

.....

(2) Reaction of silver nitrate and sodium chloride solutions forming sodium nitrate solution and white precipitate of silver chloride:

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(3) Reaction of magnesium with dilute hydrochloric acid forming dissolved magnesium chloride salt and hydrogen gas bubbles:

.....

(4) Reaction of barium chloride solution with magnesium sulfate solution forming magnesium chloride solution and barium sulfate salt:

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(5) Calcium hydroxide solution + dilute nitric acid $\rightarrow$ calcium nitrate solution + water:

.....

(6) Reaction of calcium phosphate salt with aqueous sulfuric acid forming calcium sulfate precipitate with aqueous phosphoric acid:

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Give reasons for :

Give reason : The nucleus of an atom is positively charged
Because it contains positively charged protons and neutrally charged neutrons.

Give reason : The mass of an atom is concentrated in the nucleus
Due to the negligible mass of electrons compared to the mass of both protons and neutrons.

Give reason : The mass of an atom is concentrated in the nucleus

Due to the negligible mass of electrons compared to the mass of both protons and neutrons.

Give reason : The atom is electrically neutral in its normal state

Because the number of positive protons equals the number of negative electrons.

Give reason : The mass number is often larger than the atomic number

Because the mass number equals the sum of protons and neutrons, while the atomic number equals the number of positive protons only.



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